Communicating Risk Under Title III of SARA: Strategies for Explaining Very Small Risks in a Community Context

Ann Fisher
U.S. Environmental Protection Agency
Office of Policy Analysis
Washington, D.C.

Gary H. McClelland and William D.Schulze
University of Colorado
Boulder, Colorado

From: The Journal of the Air & Waste Management Association (JAPCA), Vol. 39, No. 3 (Mar. 1989)

Under Title III of SARA, companies must provide information about chemicals that they manufacture, store, or process. Communities will use data about potential accidental releases to develop local emergency plans. Data about routine chemical releases will be made available to the public on a computer data base. Simply having such data available does not ensure consensus about reducing potential chemical risks. Laboratory and field research are summarized, indicating that people tend to edit small risks to zero as being too small to worry about, *or* to adjust them imperfectly from an anchor equal to the potential loss. These results suggest recommendations for communicating about the risks posed by accidental or routine releases of chemicals.

Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) is also called the Emergency Planning and Community Right-to-Know Act.[1] Its purpose is to facilitate informed public participation in decisions about chemical risks--at the community level where these risks occur. Companies must provide information about hazardous and toxic chemicals that are present in their facilities as part of their manufacturing, storage, or processing activities. Title III covers both accidental and routine releases.

The availability of data per se does not ensure that every community will reach an easy consensus regarding what—if anything—should be done about the potential risks posed by these chemicals. Rather, different groups can be expected to have opposing reactions to this information. Apathy and/or denial may characterize one group's responses to this avalanche of information about the presence of chemicals and their routine releases. A typical resident might say: "This is information about chemicals that have been present in my community for years. Besides, safety practices and regulations now in place have reduced the amounts of these chemicals that get into the environment. I don't know anyone who got sick from these chemicals, and the companies using them provide lots of jobs here. I don't need this information, especially because it might lower the value of my property."

Public officials can be discouraged by this type of response because the Title III data can be used to protect communities from substantial risk in specific situations. For example, the data could be used in a Local Emergency Plan to indicate that the appropriate evacuation routes depend on wind direction in case of an accidental release into the air; if residents are not aware of this, they may use evacuation routes that carry them into a pollution plume, rather than away from it. Another example is the case of communities where all companies are complying with their emission permits, but where the combined effect of these emissions may create potential "hot spots" in terms of annual emissions. If the residents ignore the Title III data, they may lose an opportunity to negotiate for changes that could reduce their potential exposure.

Public officials and business firms also are concerned about potential misinterpretation or even deliberate misrepresentation of chemical data. For example, the routine release data is reported in pounds per year; comparing 35,000 pounds of chemical X to 10,000 pounds of chemical Y may give the impression to the community and the media that chemical X represents a larger problem than chemical Y. However, this impression ignores important factors such as the comparative toxicities of X and Y and whether the release is likely to result in exposure. Special interest groups also could play on the apprehension that might be created by the sheer size of the numbers associated with the units in which the data must be reported (e.g., reporting 10,000 pounds may be far more frightening than the same information expressed as 5 tons). Public concern about the large number of pounds could lead to pressure for reducing emissions of substances much less likely to harm the community than smaller quantities of chemicals that are more toxic or more likely to result in exposure. Such considerations may result in a second group of citizens becoming overly concerned about some chemicals. The behavior of this latter group contrasts dramatically with that of the apathetic group.

When both the apathetic and concern reactions occur in the same community, there is likely to be conflict about interpreting risks revealed under Title III as well as about other risks. In this work, we use relevant research results to derive policy recommendations for communicating risks posed by either accidental or routine releases of chemicals in a community. The main objective of these recommendations is to assist government officials and members of Local Emergency Planning Committees (LEPCs) as they help citizens put the risks in context, that is, to raise community awareness of the larger risks without causing undue concern about the smaller ones.

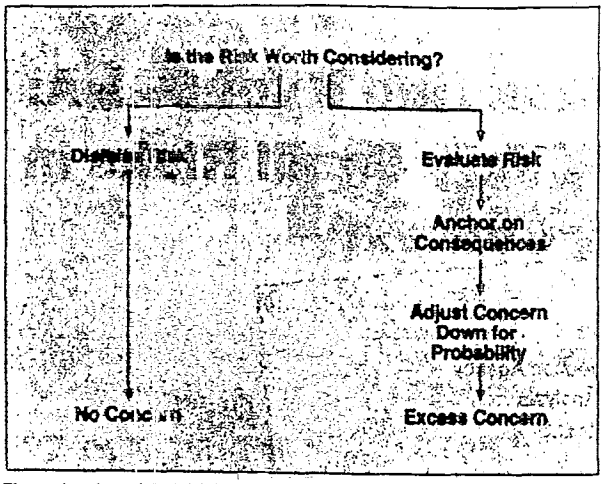

Figure 1. A model of risk judgement consistent with bimodal distributions of perceived risk.

Sara Title III—Background

Title III relies primarily on local planning and action. State commissions have been appointed to establish LEPCs, which use data relevant to potential accidental releases for preparing local emergency plans. The LEPCs must include elected state and local officials; policy, fire, civil defense, and public health professionals; hospital and transportation officials; as well as representatives from industry, community and environmental groups, and the media.[2]

Companies must participate in emergency planning if they have more than published threshold quantities of 366 substances listed as extremely hazardous.[3] They must notify the LEPCs and their state commissions about releases of these chemicals that are above specified quantities. Companies must also submit information regarding inventories of hazardous chemicals to the state commissions, LEPCs, and local fire departments. They are not required to submit this information to the U.S. Environmental Protection Agency (EPA). The law became effective on October 17, 1987.

Prior to initiation of Title III, EPA had a Community Emergency Preparedness Program, which relied on voluntary submission of information so that communities could plan for chemical emergencies.[4] Elements of this EPA program were incorporated into the Title III legislation. EPA and other federal agencies provide guidance and training for helping the LEPCs and state commissions cope with the deluge of information from companies that are required to report under Title III. For example, the National Response Team, which is composed of 14 federal agencies, has published guidelines for emergency response planning.[5] The law required that the emergency plans be ready by October 17, 1988; they must be reviewed at least annually.

Data about routine releases of over 300 listed chemicals must be submitted annually both to the states and to EPA, beginning July 1, 1988. The threshold quantity of release for reporting purposes is 10,000 pounds per year for facilities *using* a listed chemical. Facilities *manufacturing* or *processing* a listed chemical have annual reporting thresholds that decrease to 25,000 pounds per year by July 1, 1990. These data will be made available to the public by EPA through a computerized Toxics Release Inventory. States also will make the routine release data available.

The Toxics Release Inventory will provide information regarding how much of each listed chemical is released from the facility into the air, water, and land. The quality of the data is expected to be variable, because there are no monitoring requirements in the legislation. A significant concern is that this data base will not have information that relates the emissions information to the likelihood and potential consequences of exposure. There is little overlap between the chemicals that must be reported for emergency planning and those that must be reported for routine release. This is mostly because concerns about emergency releases (e.g., explosions, fires, acute health effects) often accompany different chemicals than the chemicals associated with chronic health and environmental effects that are of concern from routine releases. EPA is in the process of developing fact sheets that describe what is known about the consequences of exposure. The agency also is preparing a personal computer version of the Graphical Exposure Modeling System (GEMS), which is a model for combining routine emissions information with geographic characteristics to predict potential exposures.[6]

The legislation does not specify that LEPCs are responsible for interpreting the routine release data. However, the public may turn to the LEPCs, local and state health and environmental offices, state commissions, and even EPA officials, to help them understand the implications of Title III information. EPA recognizes that the LEPCs have the potential to be a community focus for managing both emergency and routine release risks under Title III.

Difficulties in Understanding Community Chemical Risks

To make recommendations regarding communication about chemical risks in a community, it is necessary to understand how people form beliefs about risks associated with chemicals and how these beliefs change. Figure 1 shows our model of risk judgement as a first step for explaining how the same risk information can lead some people to dismiss a risk as too small to worry about while others view the risk as a threat to themselves, their family, or their property. Several factors may affect whether a person worries about a particular risk. The first part of this section describes some of the empirical evidence supporting the model in Figure 1. The second part describes how various factors may influence possible outcomes under the proposed model.

A Model of Risk Judgement

Substantial empirical evidence indicates that people have difficulties evaluating small probabilities. McClelland et al. used laboratory experiments to demonstrate that subjects' bids (i.e., the amount they were willing to pay) for insurance against a loss were approximately equal to the expected value of the loss—as predicted by economic theory[7,8]—for probabilities of loss greater than approximately 0.1.[9] However, subjects consistently bid more than the expected value of insurance for smaller probabilities of loss.

A more detailed examination of the results from the McClelland, et al. low-probability risk experiments is shown in Figure 2a.[9] Economic theory predicts that people will bid the expected value of insurance for a particular risk, so that the ratio of bid to expected value of the insurance would be 1. However, in this experiment there were more bids at twice that ratio, and a substantial number at four times the expected value. In addition, many of the subjects bid zero for the insurance against a small probability loss. The results indicate that the distribution of the ratio of bids to expected value is bimodal.

A similar pattern can be seen in Figure 2b, which represents community beliefs about the risks associated with a Superfund site located in Monterey Park, California.[9] As in the laboratory experiments, a substantial share of residents in the community judged the risk to be zero, while approximately 30 percent perceive the risk to be as high as one in one hundred. This is much higher than the scientists' estimates of potential risk from the Superfund site. For example, EPA's risk estimates imply an upper bound on nearby residents' risk of cancer from vinyl chloride of 1.67×10^{-4}. Although the results of these two case studies need further confirmation, they do suggest that the factors resulting in

bimodal distributions of perceived risk may be the same in the laboratory experiments and in an actual situation.

Bimodal distributions of risk perceptions may be explained by two cognitive processes: 1) dismissal[10,11] and 2) anchoring and adjustment.[12-14] An intuitive explanation for these processes is that individuals confront so many low probability risks that it is impossible to develop an appropriate response for each one on the basis of analytical evaluation. One coping strategy is to *dismiss* those risks that are perceived to be below some threshold (i.e., the left side of the risk judgement model presented in Figure 1). In the McClelland et al. insurance experiments previously cited, fewer people bid for insurance as the probability of loss falls, so the amount of dismissal increases. For those who do think the risk is large enough to evaluate (i.e., the right side of Figure 1), the problem is how to decide on an appropriate level of concern (i.e., how much to bid to protect against a loss in the insurance experiments). The model indicates that people first *anchor* on the loss. That is, they focus on the magnitude of the potential loss. Then they *adjust* their concern (or bid for insurance) downward to reflect the fact that the loss will occur only some of the time. The cognitive psychology literature indicates that such adjustments nearly always are incomplete.[13,15,16] In the context of the insurance experiments, the concept of incomplete adjustment can be used to explain why the bids for insurance end up being larger than expected value (for respondents in the upper mode of the bimodal distribution).

For the previously cited insurance experiments, these cognitive processes for forming a risk perception can be shown in a simple equation:

$$B = L - (1 - e)(L - pL) = pL + e(L - pL) \qquad (1)$$

where: B = the bid for protection against loss
L = the loss if the hazard occurs
p = the probability of loss, and
e = the adjustment factor

The equation indicates that people anchor on the potential loss L and adjust this amount toward the expected value of the loss, pL. An expected value model would predict the adjustment to be $(L - pL)$, with $e = 1$. However, the term $(L - pL)$ is modified by $(1 - e)$ because the adjustment is incomplete. Using the data from the insurance experiments, the model predicts the underadjustment factor to be only 2–3 percent.[9] This error still distorts responses significantly for low probabilities because the difference between the anchor, L, and the expected value of the loss, pL, is very large for low probabilities. For example, if $L = 100$ and $p = .01$ then $(L - pL) = 99$. If the underadjustment factor is 2 percent, then $B = 2.98$. Compared with the expected value $pL = 1$, this implies an adjustment error of 1.98. As the size of the adjustment needed becomes larger, so does the adjustment error (e.g., if $L = 1000$, $(L - pL) = 990$, and $e(L - pL) = 19.8$). The adjustment error seems especially large compared with the expected value pL, which will be small for low probabilities.

Given the bimodality that is likely to occur in a community's perceptions of low-probability chemical risks, the best strategy for the LEPC (or other responsible group) may be to help people approach the more appropriate mode of either "dismissal" or "concern," while recognizing that neither mode may be accurate. In order to select the most appropriate mode, the LEPC could use data provided under Title III, additional information about whether those releases might lead to exposure, and dose-response data. The risk communication strategies needed to help people get into a concern mode may differ from those needed to help them get into a dismissal mode.

The judgement of whether the concern mode is more appropriate than the dismissal mode is not a trivial issue. The true size of the risk cannot be determined because of the uncertainties associated with various steps of the risk estimation process. Risk assessments typically yield estimates of individual risk and estimates of the total number of people affected. However, other characteristics of risk also are important to the public. This makes it likely that there will be an element of value judgement in the LEPC's (or other responsible group's) decision about which mode is more appropriate.

Determinants of Dismissal versus Concern

Several factors may influence whether people dismiss a risk or evaluate it. Some of these factors are discussed below.

Framing of gains and losses. In their description of prospect theory, Kahneman and Tversky indicated that it is important to determine whether the risk being communicated will be viewed by community residents as an increase or a decrease in their level of risk.[10,17] People are more concerned about losses than about gains relative to the status quo. This means that a perceived increase in risk (a loss) will have a greater psychological impact than the same size reduction in risk (a gain). In common sense terms, going from thinking one is "safe" to believing one is "unsafe" makes an individual comparatively unhappier than going from thinking he is "unsafe" to believing he is "safe" makes him happier.

Because most community members probably are unaware of potential risk that must be reported under Title III, the data are likely to be viewed as a new risk and a loss in well-being. Thus, the risk is more likely to be evaluated than dismissed, and it is likely to be weighted more heavily because it is viewed as a loss. If the community is judged to need help getting into the dismissal mode, these considerations suggest that expressing risks in terms of the probability that "there will not be an accident" or that "there will not be adverse health effects" may generate less concern than expressing the risks in terms of the probability that "there will be an accident" or that "there will be adverse health effects." The reverse would be true if the community is judged to need more concern.

Another framing issue is the quantitative expression of risk. Although people have difficulty understanding low-probability risk, some results of the insurance experiments indicated that bids converged toward expected value when the risk was expressed as an aggregate across several time periods.[18] Subjects were told both that the probability of loss on any given round was 0.01, and that this meant the probability of at least one loss across 25 rounds was about 0.25. The resulting bids (to protect against any loss for the block of 25 rounds) showed less of a bimodal distribution, and they were closer to the expected value.

These results suggest that it may be effective to express risks in terms of a longer time frame, such as a lifetime, at least for annual risks in the range of 10^{-2} to 10^{-3}. This strategy is less likely to succeed for smaller risks because the risk aggregated over an individual's lifetime still is smaller than the range of probabilities that most people understand. However, expressing aggregate (lifetime) risk to the neighborhood or community might have large enough probabilities to accomplish better understanding. For example, an individual lifetime risk estimate of 10^{-4} could be explained as one expected death over 70 years in a community of 10,000 people.

Experience. The amount and nature of prior experience is an important determinant of how much concern individuals will have about a risk. Risks that are familiar, for which the science is understood, and with which they have had prior benign experiences are more likely to be dismissed. Risks that are unfamiliar, not well understood, and for which there are no perceived benign experiences are more likely to generate high levels of concern.[19] For example, across 50 rounds in the insurance experiments using a probability of 0.01, the share of people in the concern mode dropped steadily with

benign experience until the adverse event actually occurred on the 33rd round.[9] Then there was a sharp drop in the fraction of subjects in the concern mode, reflecting the gambler's fallacy that a low-probability event is less likely on the next round because it occurred on the previous round. During succeeding rounds, the share of subjects in the concern mode grew as fewer and fewer people felt comfortable dismissing the risk.

Many communities will recall only benign experience relevant to Title III, and tend to be in the dismissal mode. But in communities where there has been a chemical accident or an emergency release, a high share of the population may be in the concern mode.

Characteristics of the risk. Technical risk assessment identifies which adverse effect could occur and estimates its probability of occurrence and the number of people expected to be affected. These are the only parameters included in a risk assessment. However, individual's beliefs about other factors may influence whether they dismiss or express concern about a particular risk. There are several important characteristics of risk that cause people to have more concern.[20,21] The more serious and dramatic the consequences of a risk, the higher will be the anchor in the anchoring and adjustment process, so the final level of concern will be higher. Risks that are dreaded, that can affect many people at one time, and that are considered to be unfair or morally wrong tend to result in higher concern.[19]

Personal characteristics. There is some evidence to indicate that personal characteristics affect risk perceptions. For example, people with more education, who are white, and who tend to ask a doctor a lot of questions or read regularly about health have less concern about radon.[22] Families with children, relatively young people, and women all tend to be more fearful of Superfund sites (and Superfund sites contain many Title III chemicals).[9] For the Superfund sites included in this study, education, income level and occupation were not found to have an impact on risk beliefs of people living nearby, however.

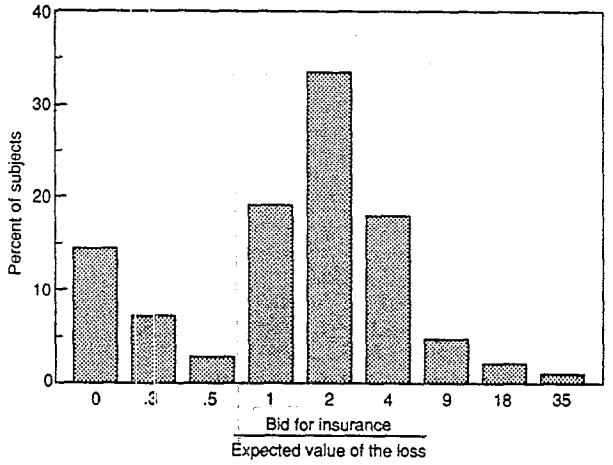

Figure 2a. Distribution of subjects' concern obtained from a laboratory experiment.[9]

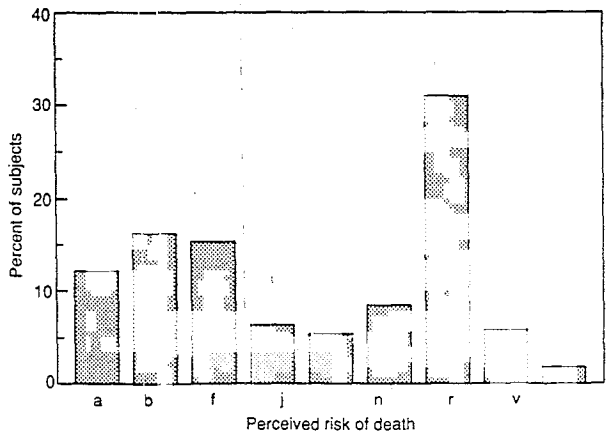

Figure 2b. Distribution of nearby residents' concerns about a Superfund site.[9] Annual risk of death: a = no risk; b = one in 9 million; f = one in 100 thousand; j = one in 10 thousand; n = one in one thousand; r = one in one hundred; v = one in ten.

Media attention. The need to maintain ratings or circulation gives the media an incentive for sensational coverage, especially when there is public controversy. Media coverage is likely to focus on those factors that encourage evaluation and lead to concern (e.g., a story reporting higher cancer rates in the area). The McClelland et al. research showed that frequent exposure to media reports about a Superfund site was significantly correlated with being in the concern mode.

Physical reminders. Risk judgements are influenced by perceptual cues. The more people are reminded of a risk, the more likely they are to be in a concern mode. Responses from 45 percent of the residents living near a Superfund site revealed that many of them perceived a dramatic decline in risk after the site was closed.[9] No special closure activities had been undertaken to safeguard the community from the wastes already at the site, but the disappearance of physical reminders such as trucks and workers on the site may have been enough to change the community's risk beliefs. Increased perceptual cues regarding Title III could come from sirens and fire trucks signalling the emergency release of a chemical, or from odors that accompany routine releases. Chemical releases that are odorless and colorless are less likely to result in people being in the concern mode.

Recommendations

The following are recommendations for LEPCs and other groups that may be asked to interpret Title III data. Some of them are consistent with risk communication guidelines already available, but others are new.[23]

- *Identify and address community concerns.* Effective risk communication is crucial if Title III is to lead to informed local decision making about chemical risks in a community context. Effectiveness requires recognition that community concerns may not be addressed by the usual components of risk assessment (e.g., residents may be worried by odors from a local chemical plant while experts may know that the odors are harmless, and not think it important to address the issue in discussions of Toxics Release Inventory data).
- *Establish and protect credibility.* Individuals communicating risk must be viewed as credible by the community. The diverse composition of LEPCs should demonstrate absence of bias toward any particular interest group. Care should be taken, however, because there are only limited public resources to support LEPCs' activities. The interests and available expertise of industry representatives on LEPCs may result in their having a large share of the committee's work. This could be perceived as self-serving. However, informed review by other committee members and the LEPC's state commission should ameliorate such concerns. Other neutral experts (from local colleges, laboratories, etc.) also may be called upon to reinforce the risk communication messages.
- *Account for typical reactions to low-level risks.* Because we observe fairly few fatal chemical accidents and chemical-related illnesses, nearly all of the Title III risks will have annual odds smaller than one in one hundred. Therefore, people will have difficulty understanding these risks and will tend either to dismiss them or to have a high level of concern about them, potentially resulting

in community conflict. The LEPC (or other responsible group) will have to decide whether the larger problem is raising awareness of those who tend to dismiss (so that they would become less likely to ignore warnings about actions to take in a chemical emergency) or reassuring those who believe routine release risks to be larger than the scientific evidence indicates. It is unlikely that all of the divergence between those in the dismiss mode and those in the concern mode can be resolved. This may be appropriate, though, because some of the community residents may be at higher actual risk.

- *Recognize that characteristics of risk matter.* A familiar, well known, and undramatic risk generates a lower level of concern than one with the same probability and consequence that is new, poorly understood, and dramatic. Even if people are convinced that the probability and consequences are the same, they still often object more to a risk that is imposed upon them than to one voluntarily sought, one that affects many people at once rather than one at a time, or one that involves dread. This may indicate that the community really wants more of its resources devoted to reducing some risks compared with others that may have a higher probability or affect more people. Such preferences should be acknowledged when communicating about risk.
- *Use comparable risks.* Risks should be expressed in concrete terms and put in perspective. Several suggestions are provided in a manual the Chemical Manufacturers Association has developed for plant managers.[24] One approach is to match characteristics of the risks posed by Title III chemicals with characteristics of other risks with which people have more familiarity. An example of using comparable risks is presented in Figure 3, which shows actual risks associated with various activities.[9] A Title III chemical could be placed on this risk ladder, next to the corresponding scientific estimate of risk. If the situation where the risk is being explained cannot accommodate the time needed to read and understand a risk ladder, one or two comparable risks can be described. Comparisons need to be used with caution, because some differences in characteristics may cause people to reject the validity of the comparisons. For example, several voluntary risks are included in Figure 3, while people in a community may feel that Title III risks are imposed on them involuntarily. An alternative risk ladder could be developed, however, with better matching of characteristics of the comparison risks and the Title III risk.
- *Treat the media as a legitimate partner.* Providing complete and consistent information to the media will minimize the likelihood that they will become catalysts for inadvertently high levels of concern. In addition, access to experts can make it easier for reporters to develop an accurate but interesting story about a risk that the LEPC views as potentially large but that people are dismissing.
- *Account for individuals' characteristics.* For example, people with young families are likely to have higher concern about risks, especially compared with the elderly. Communications need to be targeted to subgroups, accounting for ways to reach them as well as making the message personalized to help them shift into the appropriate mode of dismissal or concern.

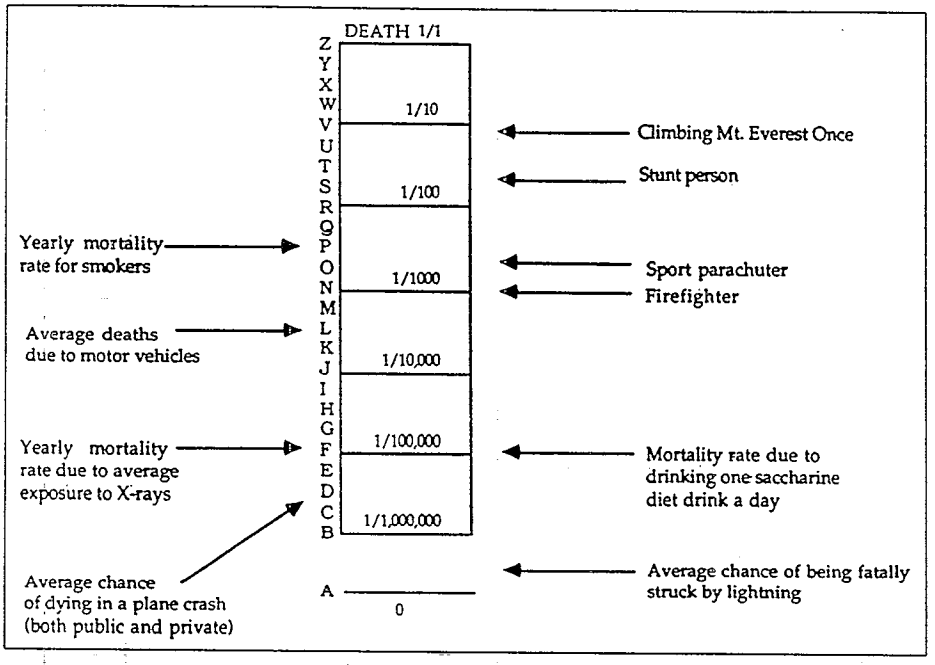

Figure 3. Example of a risk ladder, indicating risk for one year of exposure unless otherwise specified.[9]

Disclaimer

This work was presented at the APCA '88 Meeting, Dallas Texas, June 20–24, 1988. The research was partially funded by the U.S. Environmental Protection Agency. The views expressed are the authors' and should not be attributed to the funding agency or their employers.

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Ann Fisher is affiliated with the Office of Policy Analysis, PM-221, at the U.S. Environmental Protection Agency, Washington, D.C. 20460. Gary H. McClelland is with the Department of Psychology, University of Colorado, Boulder, CO 80309-4305. William D. Schulze is with the Department of Economics at the University of Colorado. This paper was submitted for peer review on April 6, 1988. The revised manuscript was received December 27, 1988.